This document is a PDF version of an on-line survey, provided by request for information and reference purposes only. It is not a perfect replica of the on-line version, which has numerous graphical display and data entry tools, in-line explanations to aid in interpretation, and so on.

Page numbers at the top of some pages (e.g., "1 of 25") indicate the survey page, and do not necessarily correspond to pages in this PDF/printed version of the survey.

Green underlined text with superscript numbers refers to interactive pop-up notes in the survey. Due the limited functionality in this pdf they are explained as footnotes at the end of this document.

IEA Wind Task 26 Survey of Expert Opinions on Future Costs of Wind Energy

Introduction

Thank you for agreeing to participate in this survey.

We are aiming to collect the opinions and assessments of top experts in the wind energy field about current and future costs of wind energy technologies, and what you expect will be the biggest drivers of changes in those costs. This survey is being conducted to support the IEA Wind Task 26 on the Cost of Wind Energy[1].

Specifically, this survey asks for your expert opinion on three issues:

- Current and future costs of wind energy,
- The broad drivers most likely to facilitate wind technology advancements and reduce wind energy costs in the future, and
- The specific technology and market areas within which advancements are expected to lead to the greatest cost reductions by 2030.

What is the goal of this study?[2] How will my input be used?[3]

Survey Notes and Instructions

- Participation in the survey is voluntary. If you choose to participate, your name and affiliation will be listed in the final report as a survey respondent. However, your individual survey responses will be kept in confidence and will not be attributed to you or your organization.

- We estimate that the survey will take you between 45 minutes and 90 minutes to complete.

- You do not have to complete the survey in a single sitting. Your data is saved each time you click the "next" button, so you can stop at any time without losing data. You can either leave your browser open and return to the survey at a later time, or you can close the browser and use your personalized link to return to the survey where you left off.

- If you close the browser and return later, you will not be able to "page back" and change your previous answers (although you will have an option to start over from the beginning, in which case your previous responses are not saved).

- The survey covers three different wind applications: onshore (i.e., land-based) wind, fixed- bottom offshore wind (e.g., monopile, jacket, gravity base), and floating offshore wind (e.g., spar buoy, semi-submersible platform, tension-leg platform). You will be able to “opt out” of questions related to an application area for which you are not comfortable providing an assessment.

- The responsible principal investigator for this survey is: Ryan H. Wiser
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If you have questions regarding the survey, please send an email directly to ieawind@lbl.gov and we will get back to you within 2 business days.

Personal Information and Areas of Expertise

Please provide the following information about yourself and your organization. (why?)[4]

Which of the following best describes your organization? (please check one)

- ☐ Public research or research management institution (e.g., NREL, ECN)
- ☐ University or other degree-granting academic institution
- ☐ Government agency not associated with research management
- ☐ Other not-for-profit organization (e.g., NGOs, international organizations)
  Wind turbine and/or component equipment manufacturer
- ☐ Wind power developer, owner, financier, and/or operator
- ☐ Construction / installation contractor
- ☐ Other private-sector wind industry member (e.g., consultant)
- ☐ Write-in other answer

Which of the following best describes your type of expertise? (please check all that apply)

- ☐ Wind energy markets and/or cost analysis
- ☐ Systems-level wind technologies, focused on the entire wind turbine and/or wind plant
- ☐ Subsystem-level wind technologies, focused on specific wind turbine and/or wind plant subsystems or components

Considering wind energy markets, technologies, and cost reduction opportunities, what regions of the world are you most familiar with? (please check all that apply)

- ☐ North America
- ☐ Europe
- ☐ Asia
- ☐ Latin America
- ☐ Other (please specify) ____________________________

If your area of expertise is focused in a single country, please state which country.

Wind Application Areas

Onshore wind. Are you comfortable considering questions about current and future technologies and costs for onshore (land-based) wind?

- ☐ Yes
- ☐ No

Offshore wind. Are you comfortable considering questions about current and future technologies and costs for offshore wind (fixed-bottom[5] and/or floating[6])?

- ☐ Yes
- ☐ No

You will still be able to “opt-out” of specific questions related to either wind application area if you feel they are outside your areas of expertise.

Currency Preference

All costs (capital costs, operating costs, levelized costs of energy, etc.) discussed in this survey will be presented in real, 2014 currency, thereby adjusted to remove the effects of general inflation. The specific currency shown can be presented and reported either in US Dollars or in Euro[7], with a conversion based on the average 2014 exchange rate[8] of 1 Euro = 1.33 US Dollar. Please indicate which currency you prefer to use.

- ☐ US Dollar
- ☐ Euro

Introduction to LCOE and Its Components

In the next few pages, we will first ask you about a baseline cost of wind energy (the costs in 2014), and then about the potential for changes to those costs in the future. (why?[9]) We will focus on the lifetime levelized cost of energy (LCOE) of wind projects.

The LCOE is the cost per unit energy of generating electricity from a specific source over an assumed project design life that allows recovery of all project expenses and meets investor return expectations. The LCOE is a function of several factors listed below, as well as assumptions about corporate taxation and inflation. (More information on LCOE and how it is calculated is available here). Factors that affect LCOE, as they are specifically defined for the purpose of this survey, include:

- **Total capital costs** (CapEx). Includes all up-front costs to the plant boundary and excludes all costs beyond the plant boundary. As defined in this survey, CapEx includes any electrical cabling within the plant, but excludes any needed substations, transmission lines, or grid interconnection costs. For offshore wind, within-plant array cabling is included, but CapEx excludes the offshore substation, any HVDC collector stations and associated cables, and costs for grid connection to land[10].
- **Levelized operating expenditures** (OpEx). Represents an annualized estimate[11] of total operating costs over the project design life, including maintenance and all other ongoing costs (e.g., insurance, land payments, etc.). As defined in this survey, OpEx excludes any costs associated with grid interconnection, substations, or transmission usage[12].
- **Net project-level capacity factor**. Annual average energy output relative to the potential output if the project operated at its maximum capacity for a full year.
- **Project design life.** The design life of a project considered by investors when deciding whether to finance a project.
- **Cost of financing** (after-tax nominal WACC). The after-tax, nominal[13] weighted average cost of capital (WACC) represents the average return required by the combination of equity and debt investors to make a project an attractive investment opportunity.

Notes for survey PDF.
Pages 5 and 6 relate to onshore (land-based) wind energy costs. If you are not comfortable answering questions about this application area, skip to page 7.

Note that there are two tables for baseline cost estimates, one in US Dollars (on this page), and one in Euro (on the next page). In the on-line version of the survey you will see only the table denominated in the currency you chose on p. 3

LCOE for Onshore (Land-based) Wind Energy in 2014

Because individual onshore wind project characteristics and locations vary greatly, the value of each of the five parameters listed on the previous page that affect LCOE (and the resulting LCOE itself) can vary over a wide range. The table below shows a range of these values that encompasses the majority of onshore (land-based) wind projects that were built (or could have been built) in 2014 in Europe and North America. For each characteristic, the midpoint of the range was identified as a default 2014 baseline value, as shown in the right column of the table.

Using these data, we calculated a baseline 2014 LCOE for onshore wind projects, also shown in the table. This resulting LCOE is intended to be representative of a "typical LCOE[19]" for onshore projects installed in (or that could have been installed in) 2014 in Europe and North America.

Onshore (land-based) wind costs, in real 2014 currency

Characteristic	Lower End of LCOE	Higher End of LCOE	Default 2014 Baseline Values
Total capital expenditures (CapEx, $/kW) *excluding grid interconnections*	$1500/kW	$2100/kW	$1800/kW
Levelized operating expenditures (OpEx, $/kW-yr)	$40/kW-yr	$80/kW-yr	$60/kW-yr
Net project-level capacity factor (%)	50%	20%	35%
Project design life (years)	20 years	20 years	20 years
Cost of financing (WACC, % nominal)	6%	10%	8%
Levelized cost of energy (LCOE, $/MWh)	$38/MWh	$190/MWh	**$79/MWh**

LCOE calculation assumes a 25% corporate tax rate, 20-year straight-line depreciation, and general inflation of 2% annually
Sources: IRENA, IEA, IPCC, Lazard, IEA Wind Task 26

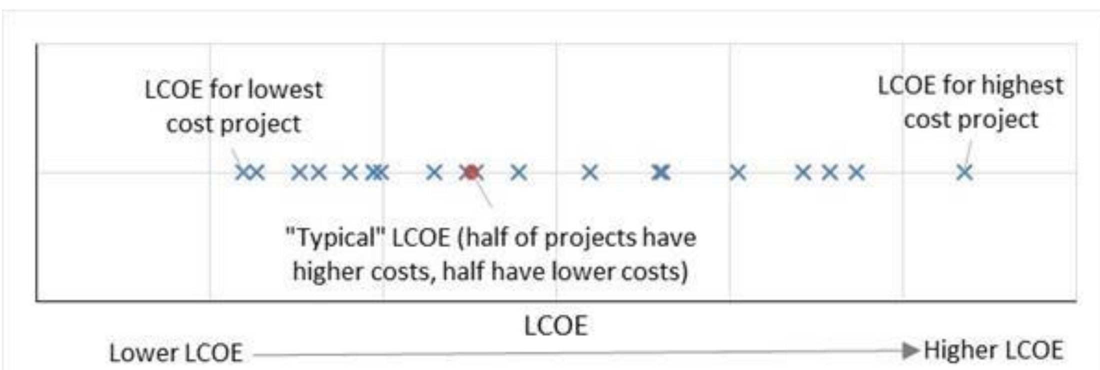
Onshore (land-based) wind costs, in real 2014 currency

Characteristic	Lower End of LCOE	Higher End of LCOE	Default 2014 Baseline Values
Total capital expenditures (CapEx, €/kW) *excluding grid interconnections*	€1128/kW	€1579/kW	€1353/kW
Levelized operating expenditures (OpEx, €/kW-yr)	€30/kW-yr	€60/kW-yr	€45/kW-yr
Net project-level capacity factor (%)	50%	20%	35%
Project design life (years)	20 years	20 years	20 years
Cost of financing (WACC, % nominal)	6%	10%	8%
Levelized cost of energy (LCOE, $/MWh)	€28/MWh	€143/MWh	**€59/MWh**

LCOE calculation assumes a 25% corporate tax rate, 20-year straight-line depreciation, and general inflation of 2% annually

Sources: IRENA, IEA, IPCC, Lazard, IEA Wind Task 26

Throughout the remainder of the survey, the "typical LCOE" designation is used to represent the median LCOE (i.e., half of all projects have costs higher than "typical," and half have costs that are lower, as illustrated in the figure below). If you feel the estimate above does not reflect the 2014 median LCOE for onshore wind in the region of the world with which you are most familiar, you may determine an alternative 2014 median value by defining independent LCOE input values on the following page.



Example: Typical LCOE as the median costs for wind projects

Are you comfortable using this value ($79/MWh or €59/MWh) to represent a baseline value for the typical LCOE for onshore wind projects newly installed (or that could have been installed) in 2014?

- ☐ Yes, use this value
- ☐ No, I prefer to specify my own values

User-specified onshore baseline LCOE

Notes for survey PDF.

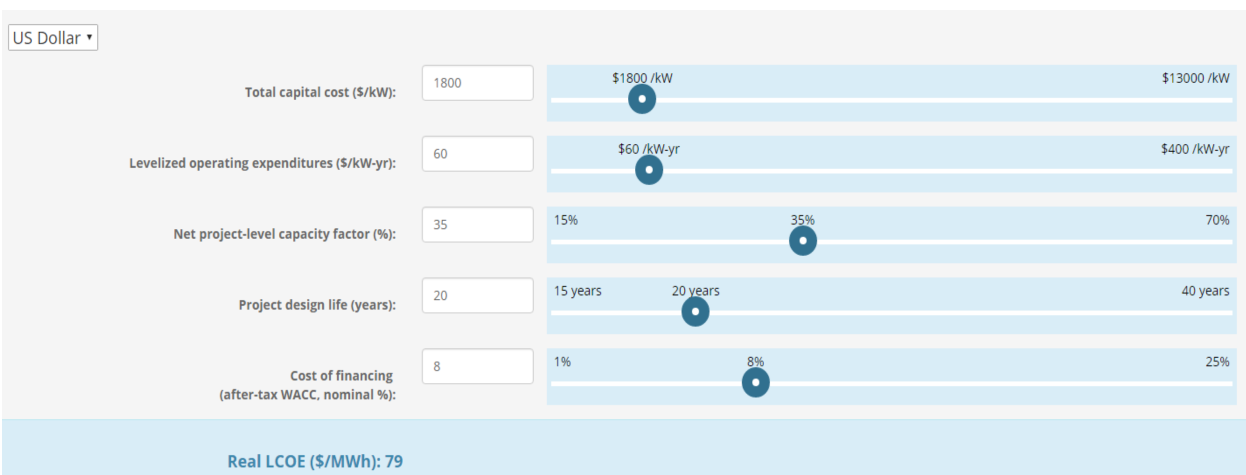
If you answered "Yes, use this value" to the previous question, skip to page 7.
If you answered "No, I prefer to specify my own values" to the previous question, you will be asked to provide your estimates for each of the five components of LCOE. The on-line survey includes easy-to-use "sliders" for each component and a calculator for the resulting LCOE value. A "stand alone" version of this calculator is available at http://rincon.lbl.gov/lcoe_v2/lcoe_calculator.html

You can record your answers on the following page and when you enter them in the survey software the LCOE will be calculated for you.

To develop your own baseline value for the typical LCOE for 2014 onshore wind projects, please identify alternative values for each of the five cost elements described previously.

Use the sliders or boxes in the calculator below to explore combinations of CapEx[14], OpEx[15], capacity factor[16], project design life[17], and cost of financing[18] that you believe are more representative of recent costs. Your cost estimates should be in real 2014 currency, and the LCOE will be calculated from your inputs.

Detailed discussion of LCOE is available here.



For what region of the world or specific country are these estimates most relevant? (please specify)

Briefly describe the basis for your 2014 baseline values.

Notes for survey PDF.

Pages 7 & 8 relate to offshore wind energy costs. If you are not comfortable answering questions about this application area, skip to page 9.

Note that there are two tables for baseline cost estimates, one in US Dollars (on this page), and one in Euro (on the next page). In the electronic version of the survey you will see only the table denominated in the currency you chose on p. 3

LCOE for Offshore Wind Energy in 2014

Because individual fixed-bottom offshore wind project characteristics and locations vary greatly, the value of each of the five parameters affecting LCOE (and the resulting LCOE itself) can vary over a wide range. The table below shows a range of these values that encompasses the majority of the fixed-bottom offshore (e.g., monopile, jacket, gravity-based) wind projects that were built (or could have been built) in 2014 in Europe and North America. For each characteristic, the midpoint of the range was identified as a default 2014 baseline value, as shown in the right column of the table.

Using these data, we calculated a baseline 2014 LCOE for fixed-bottom offshore wind projects, also shown in the table. This resulting LCOE is intended to be representative of a "typical LCOE[19]" for fixed-bottom offshore wind projects installed in (or that could have been installed in) 2014 in Europe and North America.

Note: As described earlier, these estimates are intended to exclude the offshore substation, any HVDC collector stations and associated cables, and costs for grid connection to land; transmission system use charges should also be excluded.

Fixed-bottom offshore wind costs, in real 2014 currency

Characteristic	Lower End of LCOE	Higher End of LCOE	Default 2014 Baseline Values
Total capital expenditures (CapEx, $/kW) ***excluding grid interconnections***	$3800/kW	$5400/kW	$4600/kW
Levelized operating expenditures (OpEx, $/kW-yr)	$70/kW-yr	$150/kW-yr	$110/kW-yr
Net project-level capacity factor (%)	55%	35%	45%
Project design life (years)	20 years	20 years	20 years
Cost of financing (WACC, % nominal)	8%	12%	10%
Levelized cost of energy (LCOE, $/MWh)	$95/MWh	$297/MWh	**$169/MWh**

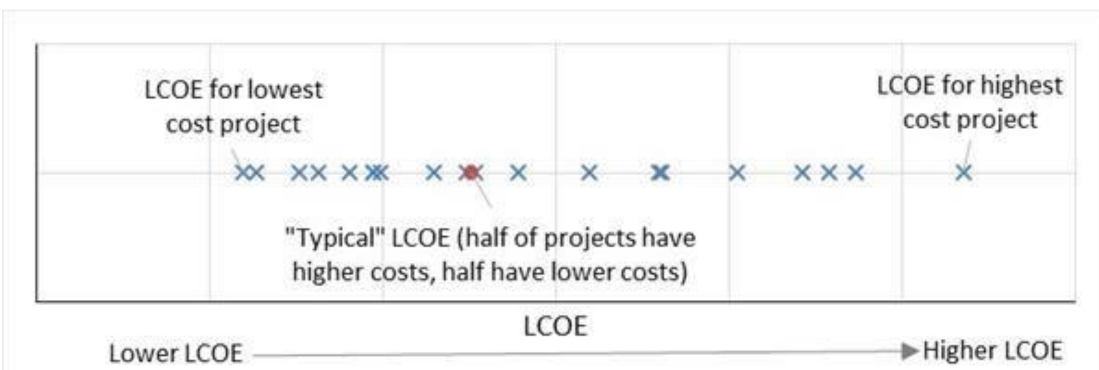
LCOE calculation assumes a 25% corporate tax rate, 20-year straight-line depreciation, and general inflation of 2% annually

Sources: IRENA, IEA, IPCC, Lazard, IEA Wind Task 26

Fixed-bottom offshore wind costs, in real 2014 currency			
Characteristic	**Lower End of LCOE**	**Higher End of LCOE**	**Default 2014 Baseline Values**
Total capital expenditures (CapEx, €/kW) ***excluding grid interconnections***	€2857/kW	€4060/kW	€3459/kW
Levelized operating expenditures (OpEx, €/kW-yr)	€53/kW-yr	€113/kW-yr	€83/kW-yr
Net project-level capacity factor (%)	55%	35%	45%
Project design life (years)	20 years	20 years	20 years
Cost of financing (WACC, % nominal)	8%	12%	10%
Levelized cost of energy (LCOE, $/MWh)	€71/MWh	€223/MWh	**€127/MWh**

LCOE calculation assumes a 25% corporate tax rate, 20-year straight-line depreciation, and general inflation of 2% annually
Sources: IRENA, IEA, IPCC, Lazard, IEA Wind Task 26

Throughout the remainder of the survey, the “typical LCOE” designation is used to represent the median LCOE (i.e., half of all projects have costs higher than “typical,” and half have costs that are lower, as illustrated in the figure below). If you feel the estimate above does not reflect the 2014 median LCOE for fixed-bottom offshore wind in the region of the world with which you are most familiar, you may determine an alternative 2014 median value by defining independent LCOE input values on the following page.



Example: Typical LCOE as the median costs for wind projects

Are you comfortable using this value ($169/MWh or €127/MWh) to represent a baseline value for the typical LCOE for fixed-bottom offshore wind projects newly installed (or that could have been installed) in 2014?

- ☐ Yes, use this value
- ☐ No, I prefer to specify my own values

User-specified offshore baseline LCOE

Notes for survey PDF.

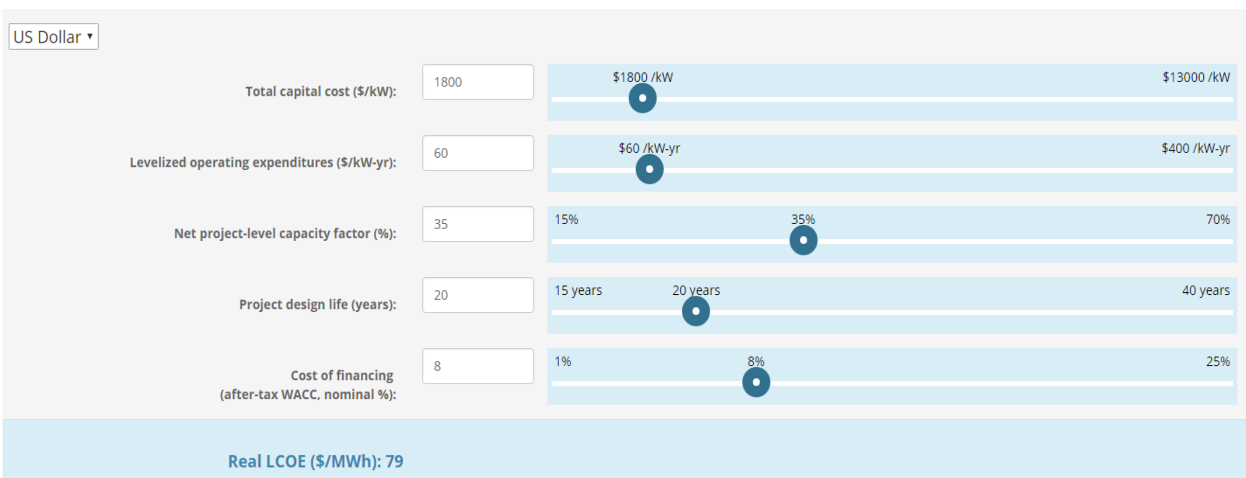
If you answered "Yes, use this value" to the previous question, skip to page 9.
If you answered "No, I prefer to specify my own values" to the previous question, you will be asked to provide your estimates for each of the five components of LCOE. The on-line survey includes easy-to-use "sliders" for each component and a calculator for the resulting LCOE value. A "stand alone" version of this calculator is available at http://rincon.lbl.gov/lcoe_v2/lcoe_calculator.html

You can record your answers on the following page and when you enter them in the survey software the LCOE will be calculated for you.

To develop your own baseline value for the typical LCOE for 2014 fixed-bottom offshore wind projects, please identify alternative values for each of the five cost elements described previously.

Use the sliders or the boxes in the calculator below to explore combinations of CapEx[14], OpEx[15], capacity factor[16], project design life[17], and cost of financing[18] that you believe are more representative of recent costs. Your cost estimates should be in real 2014 currency, and the LCOE will be calculated from your inputs.

Detailed discussion of LCOE is available here.



For what region of the world or specific country are these estimates most relevant? (please specify)

Briefly describe the basis for your 2014 baseline values.

Notes for survey PDF.

If you are not comfortable answering questions about **Onshore Wind Energy**, skip to page 12.

LCOE for Onshore Wind Energy in 2030

Obviously the costs of onshore wind projects, now and in the future, span a large range and are affected by a variety of project specific factors: this was illustrated in the range of costs discussed previously for 2014 projects. We are not interested in that full range of project-specific costs. Instead, we are interested in how much you expect the "typical" (or median) LCOE for **onshore wind projects to change in the future relative to the 2014 baseline value established earlier**.

Specifically, we would like your expert opinion on the typical LCOE for onshore wind projects installed in (or that could be installed in) 2030: both your best guess and your uncertainty about that cost, considering possible changes in wind technologies (e.g., through R&D or other advances), markets (e.g., changes in average wind speed where projects are located, or the amount of competition in the wind supply chain), and policies (e.g., policies that directly or indirectly support or impede wind energy). We are not asking for the full range of costs across all possible individual projects, only the range for what you envision as a "typical" LCOE for 2030 projects. read more about what we are asking

We are most interested in how you think wind energy technologies, markets and policies will evolve, and how those changes will affect the costs of typical wind projects. So, when you think about these future costs, including their range, please consider how you think these wind-specific drivers might change between now and 2030. However, please assume ***no changes*** in macroeconomic conditions (such as interest rates, inflation, and currency fluctuations), materials and commodity prices, and other factors not directly related to the wind energy business.

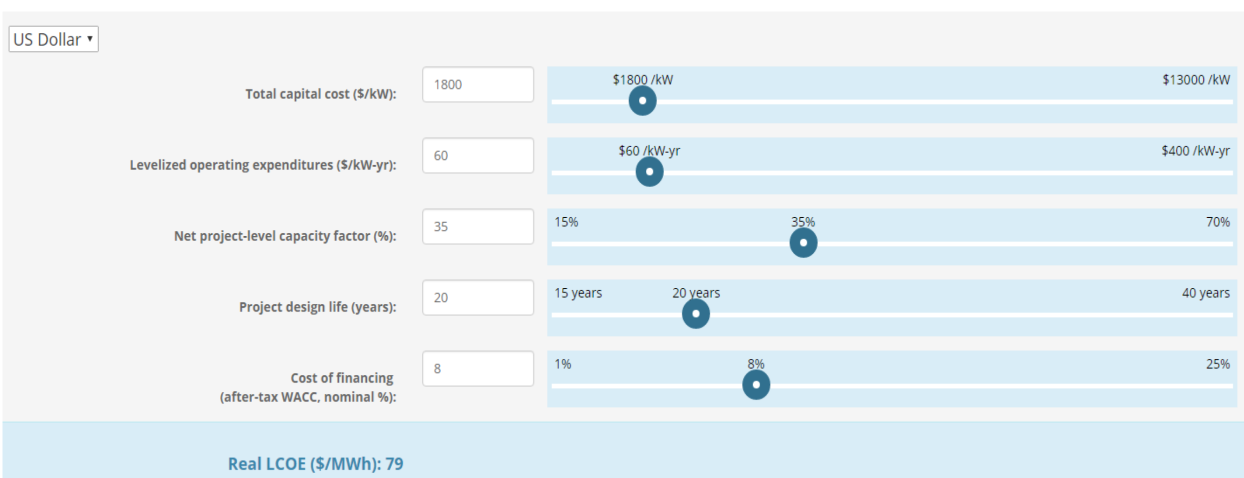
LCOE for Onshore Wind Energy in 2030

In the three questions and calculators below, we ask you to consider a **low value** for the typical LCOE of onshore wind projects newly installed (or that could be installed) in 2030, then a **high value**, and finally the **median value**, considering possible changes in wind technologies, markets and policies.

For the low value, we are looking for a value that is sufficiently low that you think there is perhaps only 1 chance in 10 that the typical (or median) LCOE for projects installed in 2030 will turn out to be lower, and for the high value, we are looking for a value such that you think there is only about 1 chance in 10 that the typical LCOE will turn out to be higher. Finally, the median value should be a value where you think that it is equally likely that the typical LCOE in 2030 will be less than or greater than the LCOE that you enter. (You can read more about what this means here)

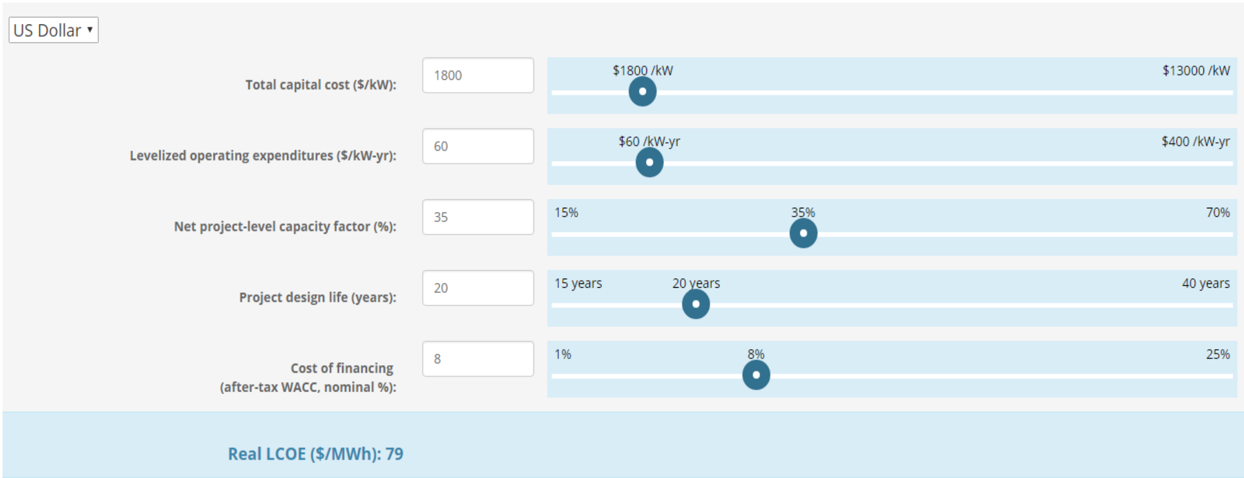
For each case, use the sliders or boxes in the calculator provided to explore combinations of CapEx[14], OpEx[15], capacity factor[16], project design life[17], and cost of financing[18] that might lead to your estimated LCOE values. Your cost estimates should be in **real 2014 currency**.

Low value for the typical LCOE for onshore wind projects in 2030



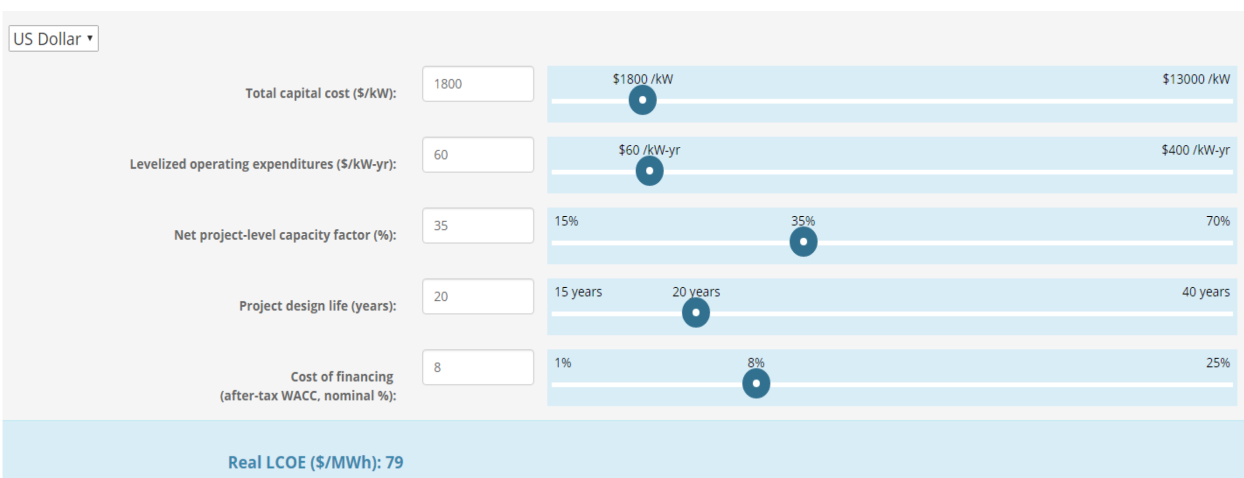
If you were thinking about a specific scenario or set of factors that would lead to this **low** value for the typical LCOE of projects in 2030, please describe that scenario briefly:

High value for the typical LCOE for onshore wind projects in 2030



If you were thinking about a specific scenario or set of factors that would lead to this **high** value for the typical LCOE of projects in 2030, please describe that scenario briefly:

Median value for the typical LCOE for onshore wind projects in 2030



If you were thinking about a specific scenario or set of factors that would lead to this **median** value for the typical LCOE of projects in 2030, please describe that scenario briefly:

LCOE for Onshore Wind Energy in 2020 and 2050

In addition to the detailed estimates you provided for the typical LCOE[1] for **onshore** wind projects installed (or that could be installed) in 2030, we are interested in what you think the cost trends will be **between now and 2050**.

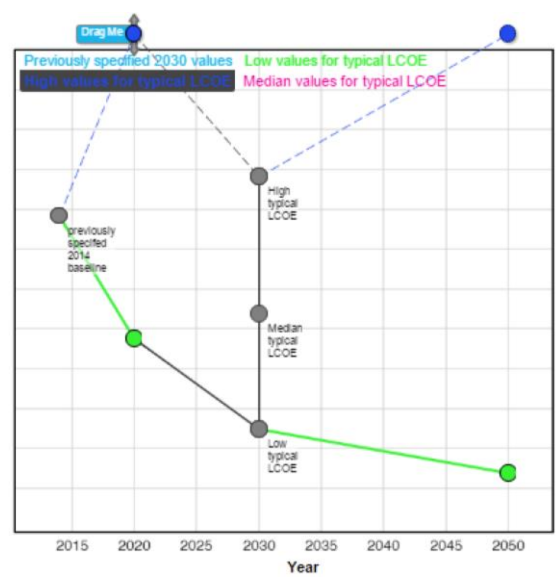
Notes for survey PDF. In the on-line survey, you will be presented with a graph that shows your estimates of low, median and high typical LCOE for 2030 (from the previous question), and will be able to "drag and drop" points representing your estimates of that range for 2020 and for 2050. An example is shown below, but you should consider your own 2030 values when making estimates for other years.

The graph below shows the baseline LCOE for 2014, and the range of values you provided for the typical LCOE of projects installed (or that could be installed) in 2030. Please use the dots labeled "Drag me" to provide a similar set of assessments for the typical LCOE for onshore wind projects installed (or that could be installed) in 2020 and 2050.

As before, first think about what you envision as a **low value** for the typical LCOE in 2020, then 2050, and place those dots on the graph. Then think about a **high value**, followed by the **median** value.

(If you wish to develop your estimates from the five core components of LCOE, please use the LCOE calculator available here)

The y-axis will adjust automatically if you wish to enter estimates outside the currently displayed range; simply drag the dot above or below the graph boundary; 2014 and 2030 values are shown in grey, indicating they can not be adjusted on this graph.



Notes for survey PDF.

If you are not comfortable answering questions about **Fixed-bottom Offshore Wind Energy**, skip to page 15.

LCOE for Fixed-bottom Offshore Wind Energy in 2030

Obviously the costs of fixed-bottom offshore wind projects, now and in the future, span a large range and are affected by a variety of project specific factors: this was illustrated in the range of costs discussed previously for 2014 projects. We are not interested in that full range of project-specific costs. Instead, we are interested in **how much you expect the "typical"** (or median) **LCOE for fixed-bottom offshore wind projects to change in the future relative to the 2014 baseline value established earlier.**

We would like your expert opinion on the typical LCOE[19] for fixed-bottom offshore wind projects installed in (or that could be installed in) 2030: both your best guess and your uncertainty about that cost, considering possible changes in wind technologies (e.g., through R&D or other advances), markets (e.g., changes in average wind speed where projects are located, or the amount of competition in the wind supply chain), and policies (e.g., policies that directly or indirectly support or impede wind energy). **We are not asking for the full range of costs across all possible individual projects, only the range for what you envision as a "typical" LCOE for 2030 projects.** read more about what we are asking

We are most interested in how you think wind energy technologies, markets and policies will evolve, and how those changes will affect the costs of typical wind projects. So, when you think about these future costs, including their range, please consider how you think these wind-specific drivers might change between now and 2030. However, please assume **no changes** in macroeconomic conditions (such as interest rates, inflation, and currency fluctuations), materials and commodity prices, and other factors not directly related to the wind energy business.

LCOE for Fixed-bottom Offshore Wind Energy in 2030

In the three questions and calculators below, we ask you to consider a **low value** for the typical LCOE for fixed-bottom offshore wind projects newly installed (or that could be installed) in 2030, then a **high value**, and finally the **median value**, considering possible changes in wind technologies, markets and policies.

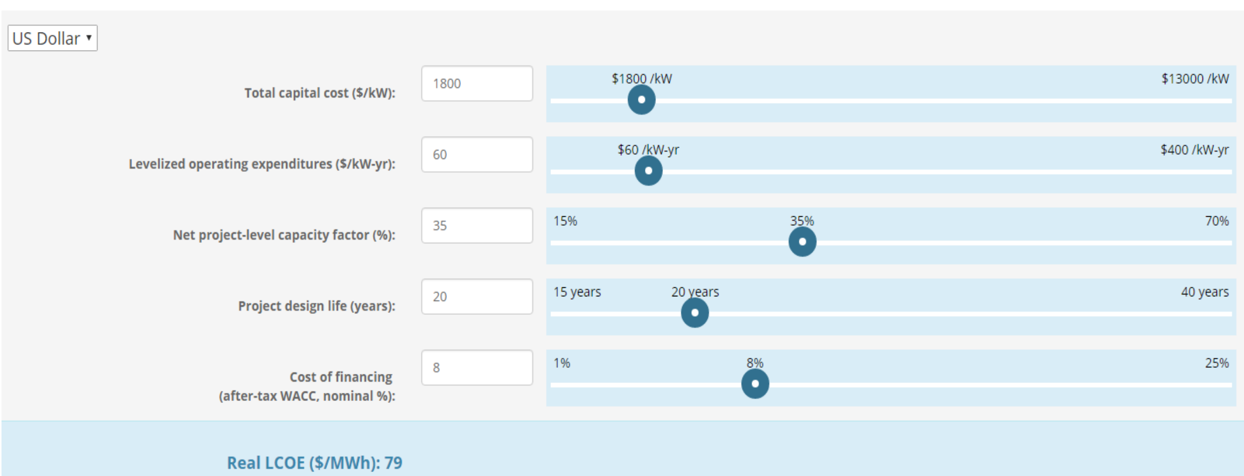
For the low value, we are looking for a value that is sufficiently low that you think there is perhaps only 1 chance in 10 that the typical (or median) LCOE of projects installed in 2030 will turn out to be lower, and for the high value, we are looking for a value such that you think there is only about 1 chance in10 that the typical LCOE will turn out to be higher. Finally, the median value should be a value where you think that it is equally likely that the typical LCOE in 2030 will be less than or greater than the LCOE that you enter.

(You can read more about what this means here)

For each case, use the sliders or boxes in the calculator provided to explore combinations of CapEx[14], OpEx[15], capacity factor[16], project design life[17], and cost of financing[18] that might lead to your estimated LCOE values. Your cost estimates should be in real 2014 currency.

Remember, these estimates should exclude the offshore substation, any HVDC collector stations and associated cables, and costs for grid connection to land; transmission system use charges should also be excluded.

Low value for the typical LCOE for fixed-bottom offshore wind projects in 2030



If you were thinking about a specific scenario or set of factors that would lead to this **low** value for the typical LCOE of projects in 2030, please describe that scenario briefly:

High value for the typical LCOE for fixed-bottom offshore wind projects in 2030

US Dollar

Total capital cost ($/kW):	1800	$1800 /kW		$13000 /kW
Levelized operating expenditures ($/kW-yr):	60	$60 /kW-yr		$400 /kW-yr
Net project-level capacity factor (%):	35	15%	35%	70%
Project design life (years):	20	15 years	20 years	40 years
Cost of financing (after-tax WACC, nominal %):	8	1%	8%	25%

Real LCOE ($/MWh): 79

If you were thinking about a specific scenario or set of factors that would lead to this **high** value for the typical LCOE of projects in 2030, please describe that scenario briefly:

Median value for the typical LCOE for fixed-bottom offshore wind projects in 2030

US Dollar

Total capital cost ($/kW):	1800	$1800 /kW		$13000 /kW
Levelized operating expenditures ($/kW-yr):	60	$60 /kW-yr		$400 /kW-yr
Net project-level capacity factor (%):	35	15%	35%	70%
Project design life (years):	20	15 years	20 years	40 years
Cost of financing (after-tax WACC, nominal %):	8	1%	8%	25%

Real LCOE ($/MWh): 79

If you were thinking about a specific scenario or set of factors that would lead to this **median** value for the typical LCOE of projects in 2030, please describe that scenario briefly:

LCOE for Fixed-Bottom Offshore Wind Energy in 2020 and 2050

In addition to the detailed estimates you provided for the typical LCOE for fixed-bottom offshore wind projects installed (or that could be installed) in 2030, we are interested in what you think the cost trends will be between now and 2050.

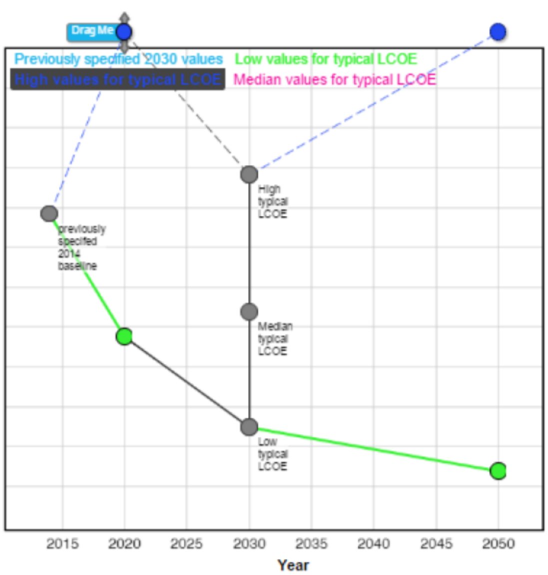
Notes for survey PDF. In the on-line survey, you will be presented with a graph that shows your estimates of low, median and high typical LCOE for 2030 (from the previous question), and will be able to “drag and drop” points representing your estimates of that range for 2020 and for 2050. An example is shown below, but you should consider your own 2030 values when making estimates for other years.

The graph below shows the baseline LCOE for 2014, and the range of values you provided or the typical LCOE of projects installed (or that could be installed) in 2030. Please use the dots labeled “Drag me” to provide a similar set of assessments for the typical LCOE for fixed-bottom offshore wind projects installed (or that could be installed) in 2020 and 2050.

As before, first think about what you envision as a **low value** for the typical LCOE in 2020, then 2050, and place those dots on the graph. Then think about the **high value**, followed by the **median** value.

(If you wish to develop your estimates from the five core components of LCOE, please use the LCOE calculator available here)

The y-axis will adjust automatically if you wish to enter estimates outside the currently displayed range; simply drag the dot above or below the graph boundary; 2014 and 2030 values are shown in grey, indicating they can not be adjusted on this graph.



LCOE for Floating Offshore Wind Energy in 2030

Finally, we are also interested in your expert opinion about the typical LCOE[19] for floating[6] offshore wind projects installed in 2030, were such a project to be built.

Are you comfortable considering questions about the LCOE of floating offshore wind (e.g., spar buoy, semisubmersible platform, tension-leg platform)?

- ☐ Yes
- ☐ No, I prefer to skip these questions

Notes for survey PDF.

If "No," skip to survey page 19; if "Yes" continue below.

LCOE for Floating Offshore Wind Energy in 2030

Obviously the costs of floating offshore wind projects in the future *also* span a large range and are affected by a variety of project specific factors. As with the previous questions about the future costs of different wind applications, we would like your expert opinion on the typical LCOE[19] for **floating offshore wind projects installed in (or that could be installed in) 2030:** both your best guess and your uncertainty about that cost, considering possible changes in wind technologies (e.g., through R&D or other advances), markets (e.g., changes in average wind speed where projects are located, or the amount of competition in the wind supply chain), and policies (e.g., policies that directly or indirectly support or impede wind energy).

We are not asking for the full range of costs across all possible individual projects, only the range for what you envision as a ''typical'' LCOE for 2030 projects.

LCOE for Floating Offshore Wind Energy in 2030

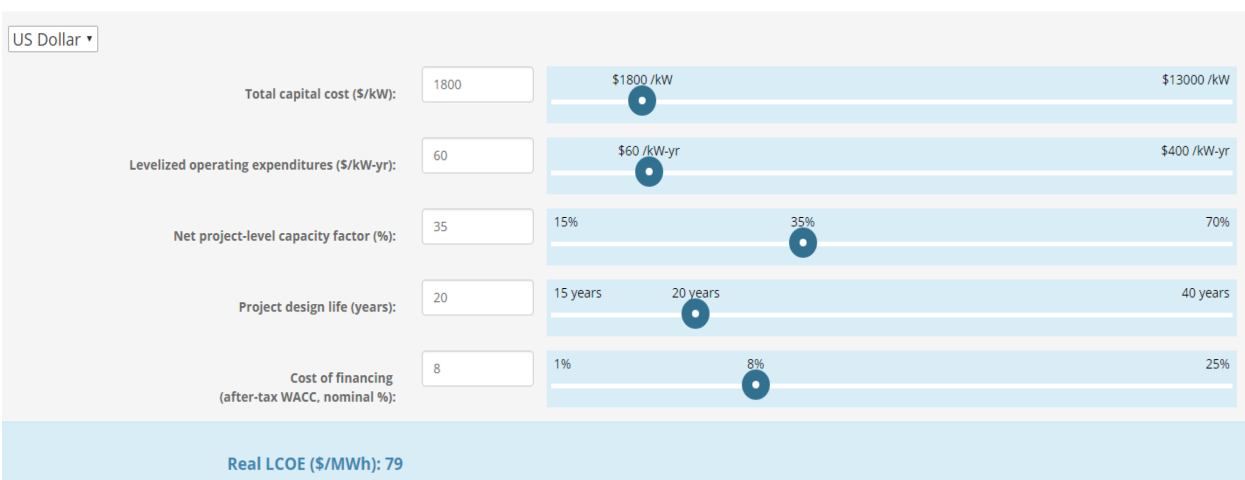
In the three questions and calculators below, we ask you to consider a **low value** for the typical LCOE of floating offshore wind projects newly installed (or that could be installed) in 2030, then a **high value**, and finally the **median value**, considering possible changes in wind technologies, markets and policies.

For the low value, we are looking for a value that is sufficiently low that you think there is perhaps only 1 chance in 10 that the typical (or median) LCOE of projects installed in 2030 will turn out to be lower, and for the high value, we are looking for a value such that you think there is only about 1 chance in10 that the typical LCOE will turn out to be higher. Finally, the median value should be a value where you think that it is equally likely that the typical LCOE in 2030 will be less than or greater than the LCOE that you enter. (You can read more about what this means here)

For each case, use the sliders or boxes in the calculator provided to explore combinations of CapEx[14], OpEx[15], capacity factor[16], project design life[17], and cost of financing[18] that might lead to your estimated LCOE values. Your cost estimates should be in real 2014 currency.

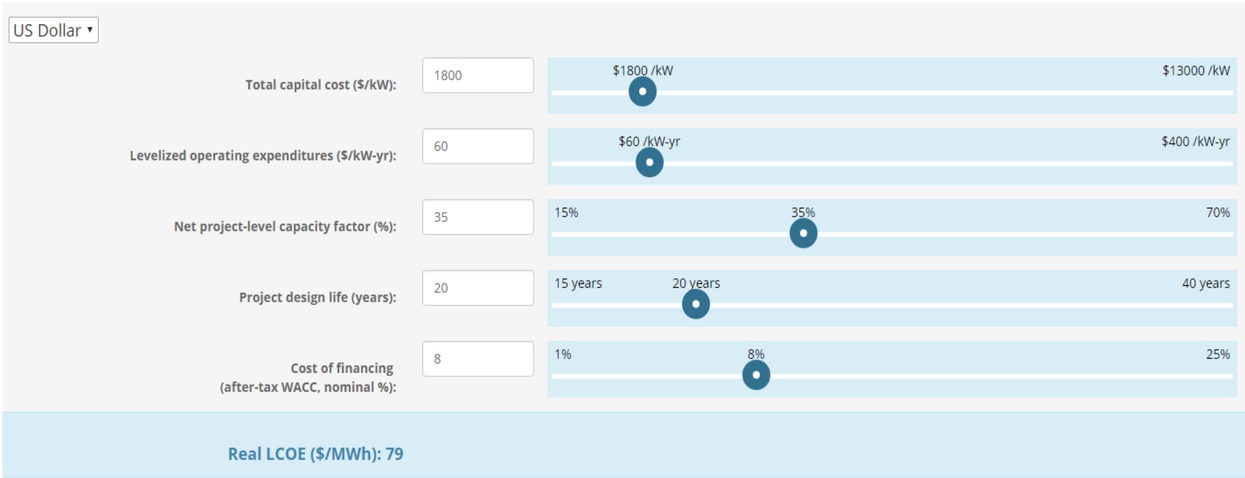
Remember, these estimates should exclude the offshore substation, any HVDC collector stations and associated cables, and costs for grid connection to land; transmission system use charges should also be excluded.

Low value for the typical LCOE for floating offshore wind projects in 2030



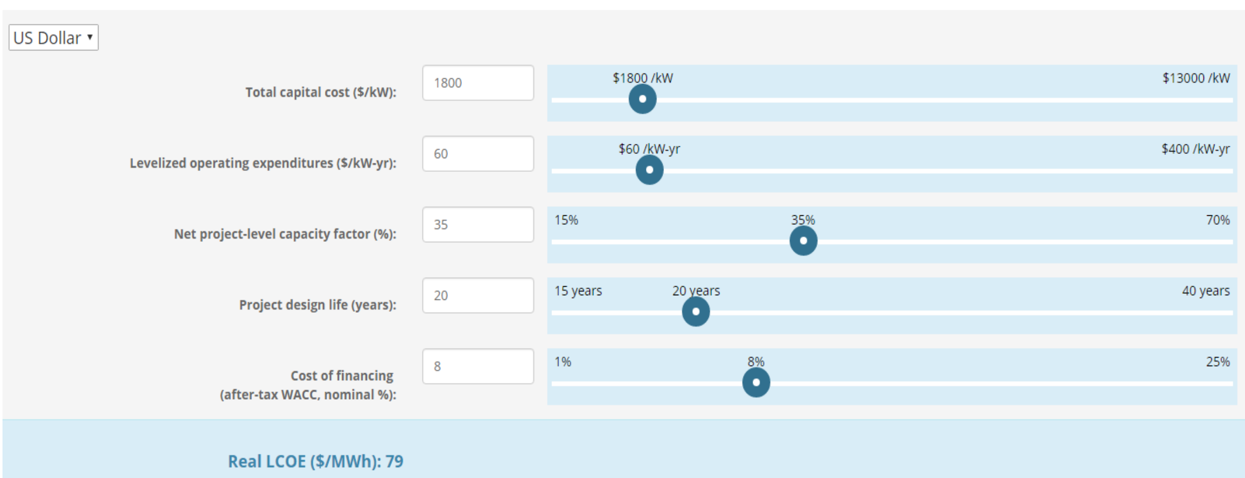
If you were thinking about a specific scenario or set of factors that would lead to this **low** value for the typical LCOE of projects in 2030, please describe that scenario briefly:

High value for the typical LCOE for floating offshore wind projects in 2030



If you were thinking about a specific scenario or set of factors that would lead to this **high** value for the typical LCOE of projects in 2030, please describe that scenario briefly:

Median value for the typical LCOE for floating offshore wind projects in 2030



If you were thinking about a specific scenario or set of factors that would lead to this **median** value for the typical LCOE of projects in 2030, please describe that scenario briefly:

LCOE for Floating Offshore Wind Energy in 2020 and 2050

In addition to the detailed estimates you provided for the typical LCOE of **floating offshore wind projects installed (or that could be installed) in 2030**, we are interested in what you think the cost trends will be in the future.

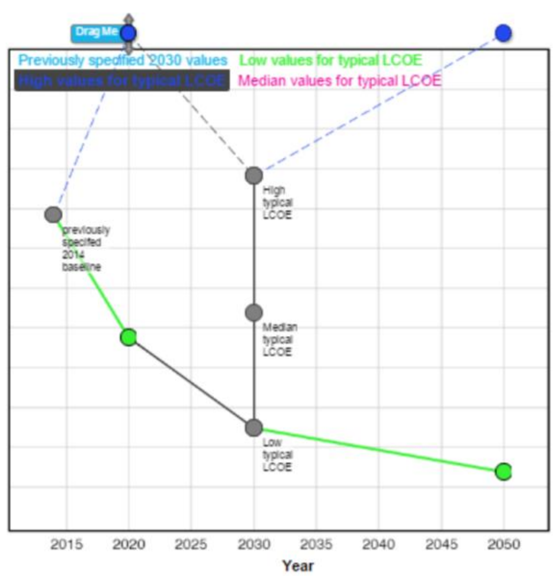
Notes for survey PDF. In the on-line survey, you will be presented with a graph that shows your estimates of low, median and high typical LCOE for 2030 (from the previous question), and will be able to "drag and drop" points representing your estimates of that range for 2020 and for 2050. An example is shown below, but you should consider your own 2030 values when making estimates for other years.

The graph below shows the range of values you provided for the typical LCOE of projects installed (or that could be installed) in 2030. Unlike the previous time-trend graph(s), no value for 2014 is shown, because no baseline values are available.

As before, first think about what you envision as a **low value** for the typical LCOE in 2020, then 2050, and place those dots on the graph. Then think about the **high value**, followed by the **median** value.

(If you wish to develop your estimates from the five core components of LCOE, please use the LCOE calculator available here)

The y-axis will adjust automatically if you wish to enter estimates outside the currently displayed range; simply drag the dot above or below the graph boundary; 2030 values are shown in grey, indicating they cannot be adjusted on this graph.



Notes for survey PDF.

p. 19 addresses cost drivers for onshore wind; p. 20 addresses cost drivers for offshore wind. Answer whichever questions are relevant for you.

In the on-line survey, these questions appear as "card sorts" -- you will be asked to rank the drivers (one per card) in order of their importance for achieving lower costs in 2030.

Broad Drivers Likely to Reduce Wind Energy Costs

There are a number of broad drivers that can contribute to reducing the costs of wind energy in the future. In this section of the survey, we identify four such drivers and are interested in your judgment about how important each of these drivers will be for achieving lower wind energy costs.

Drivers of Low Costs for Onshore Wind

In previous questions, you provided a distribution for the typical LCOE of **onshore wind projects in 2030**: low, high, and median values. Please think about the difference between a world where the typical LCOE of onshore wind projects is at your median value and a world where it is at your low value. Consider which of the following drivers is likely to play the most important role in moving from your **median** to your **low** estimate, and then place the four cards below in order of their expected importance in achieving the lower LCOE estimate for onshore wind projects in 2030 (you may add a card if you think there is another broad driver that is as important or more important than those listed).

Note that later questions will ask about more specific wind development, technology, design, manufacturing, construction, operational, and market changes that could contribute to reducing LCOE.

Research and Development: Breakthrough discoveries and technological innovation resulting from public and private sector research and development
Eased Wind Project and Transmission Siting: Reduced development costs and/or increased access to higher wind resources resulting from conditions that ease wind project and transmission siting
Learning with Market Growth: Incremental technical, manufacturing, process, and/or workforce-efficiency improvements resulting from learning with market growth
Increased Competition and Decreased Risk: Lower contingencies and greater competition within the supply chain resulting from market maturity and reduced technology and construction risk
[Optional – add your own

Broad Drivers Likely to Reduce Wind Energy Costs

There are a number of broad drivers that can contribute to reducing the costs of wind energy in the future. In this section of the survey, we identify four such drivers and are interested in your judgment about how important each of these drivers will be for achieving lower wind energy costs.

Drivers of Low Costs for Fixed-bottom Offshore Wind

In previous questions, you provided a distribution for the typical LCOE of fixed-bottom offshore wind projects in 2030: low, high, and median values. Please think about the difference between a world where the typical LCOE of fixed-bottom offshore wind projects is at your median value and a world where it is at your low value. Consider which of the following drivers is likely to play the most important role in moving from your median ($111/MWh) to your low ($81/MWh) estimate, and then place the four cards below in order of their expected importance in achieving the lower LCOE estimate for offshore wind projects in 2030 (you may add a card if you think there is another broad driver that is as important or more important than those listed).

Note that later questions will ask about more specific wind development, technology, design, manufacturing, construction, operational, and market changes that could contribute to reducing LCOE.

Research and Development: Breakthrough discoveries and technological innovation resulting from public and private sector research and development

Eased Wind Project and Transmission Siting: Reduced development costs and/or increased access to higher wind resources resulting from conditions that ease wind project and transmission siting

Learning with Market Growth: Incremental technical, manufacturing, process, and/or workforce-efficiency improvements resulting from learning with market growth

Increased Competition and Decreased Risk: Lower contingencies and greater competition within the supply chain resulting from market maturity and reduced technology and construction risk

[Optional – add your own

Future Wind Technology, Market, and Other Changes Affecting Costs

Turbine Characteristics

We would like to know how you think wind turbines will change between now and 2030. We have assembled a range of average values for wind projects installed in 2014 below. We are interested in your perspectives on what typical values for these characteristics will be in the future.

Wind turbine characteristics

	Onshore (land-based)			Fixed-bottom offshore
	United States	Europe	Germany	Europe
Turbine Capacity (MW)	1.9	2.5	2.7	3.4
Turbine Hub Height (meters)	83	n/a	116	86
Turbine Rotor Diameter (meters)	99	n/a	99	115

Notes: Data are for onshore and fixed-bottom offshore projects that achieved commercial operation in 2014. No commercial floating offshore projects are available to provide a reference point. Comprehensive data for Europe for onshore turbine hub heights and rotor diameters are not available for 2014. Based on a very limited, partial sample, 2014 rotor diameters for onshore projects in Europe averaged 97 meters for the 30% of capacity for which data were readily available.

Please answer the questions below focusing on the region of the world you are most familiar with, and consider typical values for each of the wind turbine characteristics. Please indicate the region of the world where you are most familiar with turbine characteristics.

- ☐ North America
- ☐ Europe
- ☐ Asia
- ☐ Latin America
- ☐ Other (please specify): ________________

Notes for survey PDF.

In the on-line version you will be asked the question below only for those wind applications you previous indicated you were comfortable addressing. “Drop-down” menus will give you a range of values to choose from.

Please use the dropdown boxes to provide your estimate of the typical value for each of the turbine characteristics for projects newly installed in 2030 (or that could be installed in 2030).

We are aware that there are many other turbine characteristics that might change between now and 2030—the next (final) set of questions in the survey will solicit your views on these additional trends.

If you feel you do not have enough knowledge to answer any question, either choose “no estimate” from the menu or leave the question blank.

	Turbine capacity	Turbine hub height	Turbine rotor diameter
Onshore (land-based) wind	▼	▼	▼
Fixed-bottom offshore wind	▼	▼	▼
Floating offshore wind	▼	▼	▼

Notes for survey PDF.

There are separate pages for each wind application area; again, in the on-line version you will be asked these questions only for those wind applications you previous indicated you were comfortable addressing.

Here you are asked to rate a number of different technology, market, and other changes in terms of their expected contribution to reducing costs by 2030.

Future Wind Technology, Market and Other Changes Affecting Costs

Listed below are a variety of wind development, technology, design, manufacturing, construction, operational, and market changes that could contribute to reducing the LCOE for wind projects by 2030. Please indicate what you think the contribution of each item will be to reducing costs by 2030.

Specifically, we are interested in your overall judgment about the expected impact[20] of each item on reducing the LCOE for wind projects in the future.

You will see this list of items separately for each wind application area you have previously addressed.

Onshore (Land-based) Wind

Scaling in wind turbines

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Increased turbine capacity and rotor diameter (thereby maintaining specific power[21])	●	●	●	●	●
Increased rotor diameter such that specific power[21] declines	●	●	●	●	●
Increased tower height	●	●	●	●	●

Wind plant design

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Economies of scale through increased project size	●	●	●	●	●
Improved plant-level layout through understanding of complex flow and high-resolution micro-siting	●	●	●	●	●
Large variety of alternative turbine designs to suit site-specific conditions	●	●	●	●	●
Innovative non-conventional plant-level layouts that could involve mixed turbine ratings, hub heights and rotor diameters	●	●	●	●	●

Turbine and component design

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Extended turbine design lifetime[22]	●	●	●	●	●
Integrated turbine-level system design optimization	●	●	●	●	●
Tower design advancements[23]	●	●	●	●	●
Rotor design advancements[24]	●	●	●	●	●
Nacelle components design advancements[25]	●	●	●	●	●
Innovative nonconventional turbine designs[26]	●	●	●	●	●

Foundation, support structure, and installation

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Foundation and support structure design advancements[27]	●	●	●	●	●
Installation process efficiencies[28]	●	●	●	●	●
Installation and transportation equipment advancements[29]	●	●	●	●	●

Supply chain manufacturing

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Turbine and component manufacturing standardization, efficiencies, and volume	●	●	●	●	●
Foundation and support structure manufacturing standardization, efficiencies, and volume	●	●	●	●	●

Operating expenditures and performance

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Improved component durability and reliability	●	●	●	●	●
Maintenance process efficiencies[30]	●	●	●	●	●
Maintenance equipment advancements[31]	●	●	●	●	●
Operating efficiencies[32] to increase plant performance	●	●	●	●	●
Reduced fixed operating costs[33], excluding maintenance	●	●	●	●	●

Competition, risk, development, other opportunities

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Increased competition among suppliers of components, turbines, Balance of Plant services, installation, and operations and maintenance	●	●	●	●	●
Reduced financing costs and project contingencies due to lower risk profile, greater accuracy in energy production estimates, improved risk management, and increased industry experience and standardization	●	●	●	●	●
Reduced total development costs and risks from greater transparency and certainty around siting and permitting approval timelines and procedures	●	●	●	●	●
Increased energy production due to new transmission to higher wind speed sites	●	●	●	●	●
Lower decommissioning costs	●	●	●	●	●

Others

If there are additional technology, market, or other changes that you anticipate will affect costs between 2014 and 2030, please provide a brief description (of up to 5) below, and indicate the expected impact of each.

Description	Small expected impact	Medium expected impact	Large expected impact
	●	●	●
	●	●	●
	●	●	●
	●	●	●
	●	●	●

Notes for survey PDF.

There are separate pages for each wind application area; again, in the on-line version you will be asked these questions only for those wind applications you previous indicated you were comfortable addressing.

Here you are asked to rate a number of different technology, market, and other changes in terms of their expected contribution to reducing costs by 2030.

Future Wind Technology, Market and Other Changes Affecting Costs

Listed below are a variety of wind development, technology, design, manufacturing, construction, operational, and market changes that could contribute to reducing the LCOE for wind projects by 2030. Please indicate what you think the contribution of each item will be to reducing costs by 2030.

Specifically, we are interested in your overall judgment about the expected impact[20] of each item on reducing the LCOE of wind projects in the future.

You will see this list of items separately for each wind application area you have previously addressed.

Fixed-bottom Offshore Wind

Scaling in wind turbines

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Increased turbine capacity and rotor diameter (thereby maintaining specific power[21])	●	●	●	●	●
Increased rotor diameter such that specific power[21] declines	●	●	●	●	●
Increased tower height	●	●	●	●	●

Wind plant design

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Economies of scale through increased project size	●	●	●	●	●
Improved plant-level layout through understanding of complex flow and high-resolution micro-siting	●	●	●	●	●
Large variety of alternative turbine designs to suit site-specific conditions	●	●	●	●	●
Innovative non-conventional plant-level layouts that could involve mixed turbine ratings, hub heights and rotor diameters	●	●	●	●	●

Turbine and component design

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Extended turbine design lifetime[22]	●	●	●	●	●
Integrated turbine-level system design optimization	●	●	●	●	●
Tower design advancements[23]	●	●	●	●	●
Rotor design advancements[24]	●	●	●	●	●
Nacelle components design advancements[25]	●	●	●	●	●
Innovative nonconventional turbine designs[26]	●	●	●	●	●

Foundation, support structure, and installation

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Foundation and support structure design advancements[27]	●	●	●	●	●
Installation process efficiencies[28]	●	●	●	●	●
Installation and transportation equipment advancements[29]	●	●	●	●	●

Supply chain manufacturing

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Turbine and component manufacturing standardization, efficiencies, and volume	●	●	●	●	●
Foundation and support structure manufacturing standardization, efficiencies, and volume	●	●	●	●	●

Operating expenditures and performance

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Improved component durability and reliability	●	●	●	●	●
Maintenance process efficiencies[30]	●	●	●	●	●
Maintenance equipment advancements[31]	●	●	●	●	●
Operating efficiencies[32] to increase plant performance	●	●	●	●	●
Reduced fixed operating costs[33], excluding maintenance	●	●	●	●	●

Competition, risk, development, other opportunities

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Increased competition among suppliers of components, turbines, Balance of Plant services, installation, and operations and maintenance	●	●	●	●	●
Reduced financing costs and project contingencies due to lower risk profile, greater accuracy in energy production estimates, improved risk management, and increased industry experience and standardization	●	●	●	●	●
Reduced total development costs and risks from greater transparency and certainty around siting and permitting approval timelines and procedures	●	●	●	●	●
Increased energy production due to new transmission to higher wind speed sites	●	●	●	●	●
Lower decommissioning costs	●	●	●	●	●

Others

If there are additional technology, market, or other changes that you anticipate will affect costs between 2014 and 2030, please provide a brief description (of up to 5) below, and indicate the expected impact of each.

Description	Small expected impact	Medium expected impact	Large expected impact
	●	●	●
	●	●	●
	●	●	●
	●	●	●
	●	●	●

Notes for survey PDF.

There are separate pages for each wind application area; again, in the on-line version you will be asked these questions only for those wind applications you previous indicated you were comfortable addressing.

Here you are asked to rate a number of different technology, market, and other changes in terms of their expected contribution to reducing costs by 2030.

Future Wind Technology, Market and Other Changes Affecting Costs

Listed below are a variety of wind development, technology, design, manufacturing, construction, operational, and market changes that could contribute to reducing the LCOE for wind projects by 2030. Please indicate what you think the contribution of each item will be to reducing costs by 2030.

Specifically, we are interested in your overall judgment about the expected impact[20] of each item on reducing the LCOE of wind projects in the future.

You will see this list of items separately for each wind application area you have previously addressed.

Floating Offshore Wind

Scaling in wind turbines

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Increased turbine capacity and rotor diameter (thereby maintaining specific power[21])	●	●	●	●	●
Increased rotor diameter such that specific power[21] declines	●	●	●	●	●
Increased tower height	●	●	●	●	●

Wind plant design

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Economies of scale through increased project size	●	●	●	●	●
Improved plant-level layout through understanding of complex flow and high-resolution micro-siting	●	●	●	●	●
Large variety of alternative turbine designs to suit site-specific conditions	●	●	●	●	●
Innovative non-conventional plant-level layouts that could involve mixed turbine ratings, hub heights and rotor diameters	●	●	●	●	●

Turbine and component design

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Extended turbine design lifetime[22]	●	●	●	●	●
Integrated turbine-level system design optimization	●	●	●	●	●
Tower design advancements[23]	●	●	●	●	●
Rotor design advancements[24]	●	●	●	●	●
Nacelle components design advancements[25]	●	●	●	●	●
Innovative nonconventional turbine designs[26]	●	●	●	●	●

Foundation, support structure, and installation

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Foundation and support structure design advancements[27]	●	●	●	●	●
Installation process efficiencies[28]	●	●	●	●	●
Installation and transportation equipment advancements[29]	●	●	●	●	●

Supply chain manufacturing

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Turbine and component manufacturing standardization, efficiencies, and volume	●	●	●	●	●
Foundation and support structure manufacturing standardization, efficiencies, and volume	●	●	●	●	●

Operating expenditures and performance

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Improved component durability and reliability	●	●	●	●	●
Maintenance process efficiencies[30]	●	●	●	●	●
Maintenance equipment advancements[31]	●	●	●	●	●
Operating efficiencies[32] to increase plant performance	●	●	●	●	●
Reduced fixed operating costs[33], excluding maintenance	●	●	●	●	●

Competition, risk, development, other opportunities

	No expected impact	Small expected impact	Medium expected impact	Large expected impact	No opinion
Increased competition among suppliers of components, turbines, Balance of Plant services, installation, and operations and maintenance	●	●	●	●	●
Reduced financing costs and project contingencies due to lower risk profile, greater accuracy in energy production estimates, improved risk management, and increased industry experience and standardization	●	●	●	●	●
Reduced total development costs and risks from greater transparency and certainty around siting and permitting approval timelines and procedures	●	●	●	●	●
Increased energy production due to new transmission to higher wind speed sites	●	●	●	●	●
Lower decommissioning costs	●	●	●	●	●

Others

If there are additional technology, market, or other changes that you anticipate will affect costs between 2014 and 2030, please provide a brief description (of up to 5) below, and indicate the expected impact of each.

Description	Small expected impact	Medium expected impact	Large expected impact
	●	●	●
	●	●	●
	●	●	●
	●	●	●
	●	●	●

Conclusion

Finally, if you have recommendations for additional experts we should ask to participate in this survey, please add them below (you can recommend more than one person). We will use their email addresses only to contact them to see if they are interested in participating. If you are more comfortable telling them about the survey and asking them to contact us if they are interested in participating, we would appreciate it if you ask them them to email Ryan Wiser at ieawind@lbl.gov

Name	Email address

We will send draft information on the survey results to all participants once data has been collected and reviewed, and will publish the results formally and provide you with information about the publication. In the meantime, if you have any other questions or comments please contact us at ieawind@lbl.gov

Click "submit elicitation" to let us know you are finished. Thank you!

Introduction to LCOE and Its Components

In the next few pages, we will first ask you about a baseline cost of wind energy (the costs in 2014), and then about the potential for changes to those costs in the future. *(why?[1])* We will focus on the **lifetime levelized cost of energy (LCOE) of wind projects.**

The LCOE is the cost per unit energy of generating electricity from a specific source over an assumed project design life that allows recovery of all project expenses and meets investor return expectations. The LCOE is a function of several factors listed below, as well as assumptions about corporate taxation and inflation. (More information on LCOE and how it is calculated is available here). Factors that affect LCOE, as they are specifically defined for the purpose of this survey, include:

- **Total capital costs (CapEx)**. Includes all up-front costs to the plant boundary and excludes all costs beyond the plant boundary. As defined in this survey, CapEx includes any electrical cabling within the plant, but excludes any needed substations, transmission lines, or grid interconnection costs. For offshore wind, within-plant array cabling is included, but CapEx excludes the offshore substation, any HVDC collector stations and associated cables, and costs for grid connection to land[2].
- **Levelized operating expenditures (OpEx)**. Represents an annualized estimate[3] of total operating costs over the project design life, including maintenance and all other ongoing costs (e.g., insurance, land payments, etc.). As defined in this survey, OpEx excludes any costs associated with grid interconnection, substations, or transmission usage[4].
- Net project-level **capacity factor.** Annual average energy output relative to the potential output if the project operated at its maximum capacity for a full year.
- **Project design life.** The design life of a project considered by investors when deciding whether to finance a project.
- **Cost of financing** (after-tax nominal WACC). The after-tax, nominal[5] weighted average cost of capital (WACC) represents the average return required by the combination of equity and debt investors to make a project an attractive investment opportunity.

4 of 25 | Introduction to LCOE | « | Next »

To develop your own baseline value for the **typical LCOE for 2014 onshore wind projects,** please identify alternative values for each of the five cost elements described previously.

Use the sliders or boxes in the calculator below to explore combinations of CapEx[1], OpEx[2], capacity factor[3], project design life[4], and cost of financing[5] that you believe are more representative of recent costs. Your cost estimates should be in **real 2014 currency,** and the LCOE will be calculated from your inputs.

Detailed discussion of LCOE is available here. If you set a value using the input box that is beyond the range of the slider, the slider "button" may be displayed outside this window. You can ignore this display; your answer is being correctly recorded.

Total capital costs ($/kW):

Levelized operating expenditures ($/kW-yr):

Net project-level capacity factor (%):

Project design life (years):

Cost of financing (after-tax WACC, % nominal):

Real LCOE ($/MWh):

For what region of the world or specific country are these estimates most relevant? (please specify)

Region or Country

Briefly describe the basis for your 2014 baseline values.

Basis

optional

User-specified onshore baseline LCOE

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1 IEA Wind Task 26 on the Cost of Wind Energy: The International Energy Agency's Implementing Agreement for Cooperation in the Research, Development, and Deployment of Wind Energy Systems was founded in 1974, and sponsors cooperative research tasks among its 20 Member Countries and others. Among the numerous areas of work is Task 26 on the Cost of Wind Energy.

2 What is the goal of this study?: Ultimately, our goal is to use the results of this study as one of several methods for understanding future wind energy costs and technology pathways. The results will inform policy and regulatory communities on future cost reduction potential, provide high level input into electric sector modeling assumptions, and highlight R&D opportunities.

3 How will my input be used? In reporting the results of the study, experts who contribute will be listed by name and affiliation, but individual survey responses will be kept in confidence and will not be attributed to any individual respondent.

4 Why? The answers to some of these introductory questions will be used to tailor the subsequent questions (e.g., to your chosen currency, and to ensure that you see questions only about those wind applications for which you are able to provide input). Some of the other questions will be used to help us identify and explore any systematic differences in survey responses by type of expertise or other respondent characteristics.

5 fixed-bottom: e.g., monopile, jacket, gravity base

6 floating: e.g., spar buoy, semiB-submersible platform, tension-leg platform

7 in US Dollars or in Euro: For those more familiar with other currencies, we have provided a currency translator based on the average conversion rates for 2014.

8 average 2014 exchange rate: Throughout this survey, we ask you to provide cost estimates in real, 2014 monetary units. It may be helpful to remember that the 2014 average Euro - US Dollar conversion rate was considerably higher than it is as of the fall of 2015.

9 Why? Cost changes are typically referred to either in absolute terms or in relative terms (e.g., an X% increase/decrease); we would like to be able to report the survey results in both ways, which requires us to have a baseline value to start from. We recognize, however, that there may be a range of opinions about what appropriate baseline values are, given the wide range of values seen in practice. These two sets of questions (2014 costs and future costs) will help identify whether differences between expert forecasts are a result of different opinions about where we are today, different opinions about how and how fast wind technologies will evolve, or both.

10 Costs for grid connection to land: e.g., subsea export cables, onshore substation, and onshore transmission cables.

11 Annualized estimate: Accounting for both the cost escalation with age (in real terms, excluding general inflation) and the time value of money.

12 Transmission usage: For offshore wind, transmission system use charges (e.g., payments to Offshore Transmission Owner in the United Kingdom) are also excluded.

13 After-tax, nominal: After-tax WACC may be considered either in real or nominal terms. Nominal values-used in this survey-are often preferred by developers and investors as they infer the actual cashflow to be observed. Real values are often preferred by economists and analysts, who are interested in trends independent of economy-wide inflation. In addition, the WACC may be defined in after-tax or pre-tax terms. Due to highly variable tax rules as well as the use of the tax code to incentivize wind energy in some countries, this survey relies exclusively on an after-tax WACC. Further discussion is available here.

14 CapEx: Includes all up-front capital costs to the plant boundary and excludes all costs beyond the plant boundary. Includes any electrical cabling within the plant, but excludes any needed substations, transmission lines, or grid interconnection costs. For offshore wind, within-plant array cabling is included, but CapEx excludes the offshore substation, any HVDC collector stations and associated cables, and costs for grid connection to land.

15 OpEx: Levelized total operating costs, including maintenance and all other ongoing costs (e.g., insurance, land payments, etc.). Excludes any costs associated with grid interconnection, substations, or transmission usage; for offshore wind, transmission system use charges are also excluded.

16 Capacity factor: Annual average energy output relative to the potential output if the project operated at its maximum capacity for a full year

17 Project design life: The design life considered by investors when deciding whether to finance a project

18 Cost of financing: The after-tax, nominal weighted average cost of capital (WACC) required by the combination of equity and debt investors to make a project an attractive investment opportunity. Discussion of the differences between nominal and real WACC, and the rational for using after-tax WACC for this study is included here

19 Typical LCOE: In this survey we use "typical LCOE" and "typical costs" to describe the costs of a (potentially hypothetical) project with an LCOE in the middle of the range of individual project costs. This is intended to represent the median of the distribution of project costs: half of all projects will have costs higher than "typical," and half will have costs that are lower.

20 Expected impact: Please focus your responses on the expected size of the LCOE impact (not the maximum possible impact) for typical wind projects in the region of the world you are most familiar with. In thinking about the expected impact, please consider the likelihood and the magnitude of the

specific change described, and the impact of those changes on the overall LCOE for wind projects if they occur.

21 Specific power: the ratio of turbine capacity to rotor swept area

22 Lifetime: e.g., 20 yrs to 30 yrs

23 Advancements: e.g., space-frame, modular, composite

24 Rotor design: e.g., improved aerodynamics, lighter materials, segmented blades

25 Nacelle components: e.g., novel drivetrains, lighter materials

26 Non-conventional: e.g., two bladed, vertical axis, downwind

27 Design advancements: e.g., novel materials, holistic design with turbine

28 Efficiencies: e.g., logistics improvements, larger project density

29 Equipment advancements: e.g., improved cranes, vessels, component transport vehicles

30 Process efficiencies e.g.,condition-based monitoring, economies of scale as number of projects in region increase, collaborative approaches among operators

31 Maintenance equipment e.g., improved cranes and vessels, uptower repair

32 Operating efficiencies: e.g., improved turbine- and plant-level monitoring and control

32 Operating costs e.g., insurance costs, land/ocean use payments, and local taxes